

NON-PUBLIC?: N
ACCESSION #: 9508290033
LICENSEE EVENT REPORT (LER)

FACILITY NAME: SURRY POWER STATION, Unit 1 PAGE: 1 OF 7

DOCKET NUMBER: 05000280

TITLE: Unit 1 Automatic Reactor Trip Due to Coupling Failure on
Main Feed Pump
EVENT DATE: 01/08/95 LER #: 95-001-01 REPORT DATE: 08/24/95

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 100%

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: D. A. Christian, Station Manager TELEPHONE: (804) 357-3184

COMPONENT FAILURE DESCRIPTION:
CAUSE: B SYSTEM: SL COMPONENT: LM MANUFACTURER:
X BA 65

REPORTABLE NPRDS: N
N
SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

Unit 1 was operating at 100% reactor power on January 8, 1995, when Main Feedwater Pump (MFWP) B tripped at 1552 hours on low lube oil pressure. A Unit 1 automatic reactor trip from 74% reactor power followed at 1554 hours as a result of a Steam Generator (SG) low-low water level signal. All control rods fully inserted, however, insertion of Control Rod K-2, which had a previously existing inoperable individual rod position indicator (IRPI), could not be verified. Prior flux mapping indicated Control Rod K-2 was operable and capable of being tripped. Following the reactor trip, the Turbine Driven Auxiliary Feedwater Pump (TDAFWP) started automatically but experienced diverging governor valve oscillations during its ramp to full flow and tripped approximately 52 seconds later. The MFWP B trip was caused by a sheared lube oil teflon coupling. The coupling failed due to overtightening. IRPI K-2 was

repaired and the Control Rod K-2 was verified to be fully inserted. The TDAFWP Root Cause Evaluation (RCE) determined that the most probable cause of the trip was the specific governor (governor 227) installed in the governor control system. Governor 227 was tested by the vendor but the cause of the failure was not identified. Enhancements to the TDAFWP procedures were implemented. Governor 227 will not be re-installed. This event is being reported pursuant to 10 CFR 50.73(a)(2)(iv).

END OF ABSTRACT

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1.0 DESCRIPTION OF THE EVENT

Unit 1 was operating at 100% reactor power on January 8, 1995, when the Main Feedwater Pump (MFWP) EIIS-SJ,P! B tripped at 1552 hours. The operators implemented abnormal procedures (APs), reduced turbine load and reactor power, and started a third condensate pump EIIS-SD,P! in an effort to restore stable conditions. The main steam dump valves EIIS-SB,V! automatically opened as designed to reduce the Tave/Tref mismatch caused by the operator initiated load reduction. The SG levels initially stabilized, but as the steam dumps modulated to the fully closed position, the SG levels shrank due to the pressure increase in the SGs.

At 1554 hours, Unit 1 experienced an automatic reactor trip from approximately 74% reactor power due to a SG low-low water level reactor protection system trip signal from SG A. Following the trip, all rods indicated full insertion into the core with the exception of rod K-2 which had a previously existing inoperable individual rod position indicator (IRPI) EIIS-AA,ZI!.

The Reactor Coolant System (RCS) EIIS-AB! cooled down below the 547 degrees F Tave (no load temperature) and reached a minimum of 528 degrees F. RCS temperature subsequently stabilized at 547 degrees F after closing the main steam trip valves and securing the Auxiliary Feedwater Pumps (AFWPs) EIIS-BA,P!. The reactivity shutdown margin was calculated following the RCS cooldown to ensure that Technical Specification and administrative shutdown margin limits were satisfied.

The turbine EIIS-TA! and generator EIIS-TB! tripped as designed. The motor driven and turbine driven AFWPs auto started on SG low-low level. During the ramp to full flow, the TDAFWP experienced divergent governor valve oscillations and tripped due to overspeed at 1555 hours, 52 seconds after it automatically started. The pump

was declared inoperable. The motor driven auxiliary feedwater pumps and the MFWP A provided adequate feedwater flow to the steam generators.

At 1855 hours, a four hour non-emergency report was made to the Nuclear Regulatory Commission in accordance with 10 CFR 50.72 (b)(2)(ii). This event is being reported pursuant to 10 CFR 50.73(a)(2)(iv), automatic actuation of the Reactor Protection System (RPS) EHS-JC!.

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2.0 SAFETY CONSEQUENCES AND IMPLICATIONS

This event resulted in no safety consequences or implications. Appropriate operator actions were taken in accordance with abnormal and emergency operating procedures to ensure the performance of system automatic actions and to respond to abnormal conditions. On the SG low-low level signal, auxiliary feedwater flow initiated, as designed, and provided flow to the generators. Following the trip of the TDAFWP, the motor driven pumps continued to run until they were secured at 1602 hours. The MFWP A continued to operate during the event. All rods indicated full insertion into the core with the exception of rod K-2 which had a previously existing inoperable rod position indicator. This control rod was assumed to be fully withdrawn from the core for the purposes of the Shutdown Margin calculations performed immediately following the trip. Prior flux mapping for the K-2 IRPI, conducted pursuant to Technical Specifications (TS) 3.12.E requirements, indicated that this control rod remained operable and capable of being tripped. After the faulty IRPI cable was replaced, the K-2 IRPI indicated that the K-2 Control Rod was fully inserted.

The unit was brought to a stable hot shutdown condition. No conditions adverse to safety resulted from this event and the health and safety of the public were not affected.

3.0 CAUSE

The cause of the reactor trip was the loss of the MFWP B which automatically tripped on low lube oil pressure. The low lube oil pressure was caused by failure of a teflon coupling in the lube oil return line of the inboard motor 1-FW-PMO-1B2 inboard bearing. The primary cause for the failure of the teflon coupling was over-tightening.

Following the reactor trip, Control Rod K-2 could not be verified to be inserted due to a previously failed IRPI. Troubleshooting revealed a faulty IRPI cable located inside Containment.

The TDAFWP started as required on low-low SG level and then tripped. Post trip evaluation indicated diverging oscillations in steam flow to the TDAFWP turbine as the pump ramped to full flow. A Category I Root Cause Evaluation, initiated on January 9, 1995, determined that the oscillations resulted from the TDAFWP governor control system. The system was determined to be dynamically unstable. This instability caused the oscillations and consequently the TDAFWP to increase in speed to the overspeed trip

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setpoint. System stability was restored and diverging oscillations eliminated when the installed governor, serial number 2435227 (governor 227), was replaced.

The type of diverging oscillations in steam flow to the TDAFWP turbine occurred only when the governor 227 was installed in the governor control system. Dynamic, static and material tests on governor 227, after it was removed, did not determine the cause of the failure. The tests, however, were not conducted under field conditions which would include the dynamic characteristics of the pump and turbine. The TDAFWP has not experienced oscillations or trips since the replacement of the governor 227.

4.0 IMMEDIATE CORRECTIVE ACTIONS

Following the trip, Control Room Operators acted promptly to place the plant in a safe hot shutdown condition in accordance with emergency and other operating procedures. The Shift Technical Advisor calculated the shutdown margin and monitored the critical safety function status trees to verify that the unit conditions were acceptable. Plant response was as expected and the unit was stabilized at hot shutdown.

The Unit 1 TDAFWP was quarantined until the cause of the overspeed trip could be investigated by the RCE Team.

5.0 ADDITIONAL CORRECTIVE ACTIONS

When the main steam dumps automatically opened to admit steam directly to the main condenser, the RCS average temperature (Tave) decreased below 547 degrees F to a minimum of 528 degrees F. The

RCS subsequently stabilized at 547 degrees F (no-load temperature). The RCS cooldown below no-load temperature is expected and has been observed in previous reactor trips. The cause of this cooldown is well documented and is the subject of a previous RCE. Corrective actions are being taken as a result of the previous evaluation. The reactivity shutdown margin was calculated following the RCS cooldown to ensure that Technical Specification and administrative shutdown margin limits were satisfied.

The teflon coupling on the MFWP B lube oil return line was replaced and the pump was returned to service. The remaining lube oil line teflon couplings on Unit 1 and 2 MFWPs were inspected for indications of over-tightening and were replaced, as needed. A Category II RCE was initiated to document the cause of the coupling failure.

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A Containment entry was made to troubleshoot the K-2 IRPI. The investigation revealed a faulty IRPI cable. A spare cable was placed in service and the K-2 IRPI was satisfactorily tested and returned to service. The K-2 IRPI indicated that the Control Rod K-2 was fully inserted.

As a precautionary measure, the Unit 2 TDAFWP was also declared inoperable until further testing and evaluation could verify operability. A 72 hour LCO was entered to restore the pump to operable status. Testing was completed satisfactorily at 0131 hours on January 9, 1995. After engineering review of the test results, the Unit 2 TDAFWP was declared operable and the LCO was exited at 1645 hours on January 9, 1995. A satisfactory cold start test which also tested for governor instability was performed on January 15, 1995.

A multi-discipline Category I Root Cause Evaluation Team including station and corporate representatives was formed: 1) to identify the cause of the overspeed trip experienced by the TDAFWP; 2) to determine if this overspeed trip was similar to previous overspeed trips; and 3) to identify corrective actions to prevent reoccurrence of the overspeed trip. The team was supplemented by a representative from the Institute of Nuclear Power Operations (INPO), a consultant, and field service personnel from the turbine and governor vendors.

TDAFWP trips prior to the governor replacement in December 1994 were evaluated and determined not to have the dynamic instabilities

experienced during the January 8, 1995 trip. A previous root cause evaluation completed on these TDAFWP trips adequately documents the causes of the trips prior to December 1994. Similarities were observed between the trip on January 8, 1995 and the return to service testing of the governor in December, 1994. However, oscillations experienced in December were eliminated by adjustments to the governor control system. Following satisfactory testing (two tests), the TDAFWP was returned to service on December 25, 1994. The TDAFWP was also tested and verified operable on December 27, 1995.

Evaluation and testing by the root cause team determined that the most probable cause of the TDAFWP overspeed trip was unstable characteristics of the installed governor control system, including the governor, governor valve and the governor linkage. Following extensive investigation of As Found conditions, including additional testing, governor 227 was replaced and the quarantine was lifted.

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The replacement governor, serial number 2435228 (228), was dynamically tested for stability. Stable operation of the TDAFWP was verified and the pump was declared operable at 1430 hours on January 14, 1995. Six additional cold start tests and seven monthly inservice surveillance tests on the TDAFWP were completed satisfactorily since the pump was declared operable.

Governor 227 was returned to the manufacturer (Woodward) to perform static and dynamic tests, dimensional checks of critical components and material condition inspections. The tests did not determine the cause of the failure, however, the testing was performed only on the governor and did not include the dynamic characteristics of the pump and turbine.

A dynamic model of the governor control system was developed to identify the primary factors that affect stability of the TDAFWP governor control system and to confirm that the system has adequate stability margin over a wide range of operating conditions. The analysis identified the primary factors particularly sensitive to the system. The stability analysis also concluded that the control system, when operating as designed, is stable and has an adequate amount of stability margin.

6.0 ACTIONS TO PREVENT RECURRENCE

The Category II RCE on the MFWP lube oil system teflon coupling has

been finalized and a design for the replacement of the teflon couplings has been approved. The teflon coupling will be replaced with a metal coupling and connected to an insulated return line.

The testing which was completed following governor replacement to return the TDAFWP to service December 25, 1994, and also during a subsequent test on December 27, 1994, did not identify the instability experienced during the trip on January 8, 1995. As a result of the root cause investigation of the quarantined TDAFWP, post maintenance testing requirements have been upgraded to verify governor stability following maintenance on the governor control system.

TDAFWP procedures have been revised to include more detailed information on the governor and governor linkage field set-up. Additional recommendations from the RCE will be implemented. These changes include modification of the governor linkage to ensure vertical alignment and replacement of the governor connecting rod with a solid control rod.

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Governor 227 will not be re-installed. Initial results of the Category I RCE were distributed on the INPO Nuclear Network on January 25, 1995. An update will be provided to the Nuclear Network.

7.0 SIMILAR EVENTS

LER S1-93-002-00 Reactor Trip Due to Low Steam Generator Water Level Coincident with Steam/Feedwater Flow Mismatch Resulting From Main Feedwater Pump Trip

8.0 MANUFACTURER/MODEL NUMBER

Manufacturer: Woodward Governor Company
Equipment: Turbine Driven Auxiliary Feedwater Pump Governor (Model No. PG-PL)

9.0 ADDITIONAL INFORMATION

Unit 2 was operating at 100% reactor power and was not affected by this event. As a precaution, the Unit 2 TDAFWP was declared inoperable until further tests and an engineering evaluation determined the pump to be unaffected by causes that resulted in the Unit 1 TDAFWP failure.

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10CFR50.73

Virginia Electric and Power Company
Surry Power Station
5570 Hog Island Road
Surry, Virginia 23883

August 24, 1995

U. S. Nuclear Regulatory Commission Serial No.: 95-354
Document Control Desk SPS:BAG
Washington, D. C. 20555 Docket No.: 50-280
License No.: DPR-32

Dear Sirs:

Pursuant to Surry Power Station Technical Specifications, Virginia Electric and Power Company hereby submits the following Licensee Event Report applicable to Surry Power Station Unit 1.

REPORT NUMBER

50-280/95-001-01

This report has been reviewed by the Station Nuclear Safety and Operating Committee and will be forwarded to the Management Safety Review Committee for its review.

Very truly yours,

D. A. Christian
Station Manager

Enclosure

cc: Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

M. W. Branch
NRC Senior Resident Inspector
Surry Power Station

*** END OF DOCUMENT ***
